

CHAPTER D5

ELECTRICAL AND ELECTRONIC SAFETY AND TAG-OUT PRECAUTIONS

D0501. DISCUSSION

a. Practically every piece of equipment on board ship requires electrical power. Radars, communication equipment, as well as lighting, portable tools, and personal equipment all use power from the ship.

b. The fact that electrical equipment and tools are so commonplace means that hazards involved with electricity are often taken for granted. This is despite the fact that the hazards of electrical shock are commonplace ashore where the extra shipboard hazards of high-powered equipment, unstable work spaces, and saltwater are usually non-existent. Compared to other environments, the potential for electrical shock aboard ship is increased. Although ships' electrical/electronic systems are ungrounded, personnel and equipment may easily become a path to ground in cases of faulty wiring, resulting in injury or death or damage to equipment.

c. Refer to Naval Ships Technical Manual (NSTM) Chapter 300, Electric Plant General, for further guidance.

D0502. DEFINITIONS

a. "Electrical equipment" shall include generators, electrically-powered machinery and mechanisms, power cables, controllers, transformers, and associated equipment.

b. "Electronic equipment" shall include radars, sonars, radios, power amplifiers, antennas, electronic warfare equipment, computers, and associated controls and peripherals.

D0503. ELECTRICAL PRECAUTIONS

a. General Precautions for Portable Electrical Equipment. Portable electrical equipment are devices that may be plugged into the ship's electrical power. All personnel using portable electrical tools shall:

(1) Wear rubber gloves when using electric portable tools in hazardous conditions, such as wet decks or bilge areas.

(2) Wear leather gloves over rubber gloves when the work being done could damage the rubber gloves.

(3) Wear eye protection (Z-87.1-approved) when working where particles may strike the eyes.

(4) Wear hearing protection (earplugs or circumaural muffs) when working with noise hazardous tools or in the area where such work is being conducted.

(5) Not use spliced cables.

(6) Not use any portable equipment that has a frayed cord or broken/damaged plug.

(7) Make sure that the on/off switch is in the "off" position prior to inserting/removing the plug from the energized receptacle.

(8) Always connect the cord of a portable electrical equipment into the extension cord before the extension cord is inserted into an energized receptacle.

(9) Always unplug the extension cord from an energized receptacle before the cord of the portable electrical equipment is unplugged from the extension cord.

(10) Arrange the cords so that they will not create a tripping hazard.

(11) Never pick up the tool by the electrical cord.

(12) When drilling/cutting through bulkheads, check opposite side for cables and pipes.

(13) Only use electric equipment in explosive atmospheres if the equipment is approved for such use (explosion proof).

(14) Do not allow cords to run through hatches, chemicals, scuttles, or watertight doors or over sharp objects or hot surfaces.

(15) Do not join more than two 25-foot extension cords together.

(16) When it is necessary to run electrical leads through doors or hatches, protect the cord to guard against accidental closing of the door or hatch.

(17) Return portable electrical power tools, drop cords, and extension cords, to the proper location to prevent damage to the equipment.

(18) Use only COMNAVSEASYSCOM-authorized extension lights for shipboard use in order to eliminate or drastically reduce the many hazards associated with the use of unauthorized commercial grade lights.

b. Do not touch a conductor, until it is tested to be sure it is de-energized.

c. Obey all warning signs; read equipment warning labels before use.

d. Never work on live (energized) electrical equipment without the commanding officer's permission and only per paragraph B0707 of this manual.

e. Always de-energize and "tag-out" with red **"DANGER, DO NOT OPERATE"** tags, installed electrical equipment before starting any maintenance or repair.

f. Do not energize any equipment that is tagged-out. Properly clear the tag first.

g. Only use authorized equipment to perform maintenance on electrical equipment.

h. Close all fuse boxes, junction boxes, switch boxes, and wiring accessories.

i. Never operate a switch with the other hand on a metal surface.

j. Never use outlets that appear to be burnt.

k. Ensure that "dead-man" switches work properly when installed.

l. Use a voltage meter to test whether equipment or circuits are energized.

m. Never remove overload relays except for replacement or preventive maintenance.

n. Use all safety precautions in NSTM, Chapter 300 when working on energized circuits or equipment.

o. Use skin and eye protection when working with wet cell batteries.

p. Visually inspect portable cables, such as shore power "pigtails", for any sign of an unsatisfactory condition, such as tears, chafing, exposed insulated conductors, and damaged plugs and receptacles. Cables shall be of the proper length and cross-sectional area. Do not use spliced portable cables except in emergency conditions, as outlined in Naval Ships Technical Manual, Chapter 300, paragraph 300-4.6.8.

D0504. BATTERIES

a. Main Storage Batteries

(1) Observe the following safety precautions when working in the battery well:

WARNING

Remove all metal from body and pockets.

(a) Do not enter the battery well while a charge is in progress.

(b) Never work alone in the battery well except when performing daily gravity checks.

(c) Make no repairs to battery storage connectors when battery current is flowing.

(d) Measure battery ground resistance prior to any work which involves the battery well. Insulate the body from ground by using a rubber sheet.

(e) Use only insulated tools and non-metallic flashlights in the battery well. Be very careful never to short-circuit any part of the battery. Appropriate precautions should be taken (i.e., insulated carrying tray) to ensure that no tools or equipment are dropped between battery cells.

(f) Tools used in the battery well shall be shorter than the distance between metal terminals, when practical.

(g) Ground detectors should never be used with personnel inside the battery well due to the potential for electrical shock.

(h) Keep cell service openings closed except when they must be opened to take readings or add water.

(i) Keep cell tops clean.

(j) Never stow loose gear in the battery well. Gear such as cleaning rags, hydrometer boxes, pieces of wire, and tools must be removed immediately after use.

(k) Station a fire watch in the battery well whenever hot work is being performed at a well boundary. Have an insulated CO₂ fire extinguisher available for minor fires. Two insulated CO₂ fire extinguishers should be mounted near the battery well.

(2) The charging of batteries will produce hydrogen gas that may be ignited causing fire and explosion. Keep the battery well properly ventilated during charging.

(3) Post a warning placard at the storage battery well access while battery charging is in progress.

(4) Hydrogen is emitted from lead acid batteries during discharge, stand, or charge, and therefore must be continuously ventilated.

(5) Hydrogen detectors must be operated continuously with readings taken at either 15- or 30-minute intervals, depending on the voltage or charging rate. See NSTM chapter 223, volume I, paragraph 223-3.61 for details.

(6) Do not pour water into concentrated sulfuric acid. The heat generated will cause a violent reaction. Sulfuric acid is highly corrosive. Wash up spillage with water and sodium bicarbonate. When handling acid or electrolyte, always wear a rubber apron, rubber boots, rubber gloves, chemical goggles, and a face shield. Know locations of nearest emergency eyewash station.

(7) Do not charge a battery for which the resistance is less than 100,000 ohms.

(8) Add to the battery only pure distilled water or water that analysis has found to be pure enough for battery use. Do not use the battery watering hose for any other purpose.

(9) Refer to Naval Ships Technical Manual, Chapter 223 and applicable technical manual for battery charging and maintenance procedures.

b. **Equipment Batteries**

(1) Mercury batteries shall not be used in nuclear submarines without approval of COMNAVSEASYS COM.

(2) Lithium batteries shall not be used aboard ship without specific approval of COMNAVSEASYS COM.

(3) Primary batteries, especially mercury and lithium batteries, shall never be punctured, incinerated or recharged.

(4) Dispose of mercury and lithium batteries promptly as hazardous waste. Mercury cell batteries shall be disposed of at the first shore installation. Lithium batteries shall not be stored at sea for shore disposal, but shall be disposed of in water over 600 feet deep per Chapter B3 of this manual. Ashore, dispose of lithium batteries per Chapter B3 of this manual.

(5) Remove batteries from equipment before shipment or storage. Cover terminals of batteries with an insulating material to prevent short circuits.

(6) Store spare and used batteries in an adequately ventilated and cool fireproof area.

(7) Turn battery switch off when equipment is not in use or after the battery fails to operate the equipment.

D0505. ELECTRICAL FIRES

a. For electrical fire fighting procedures, see Naval Ships' Technical Manual, Chapter 555.

b. **Main Storage Battery Fires**

(1) A battery fire is nearly always preceded by an explosion. Great care is required fighting such a fire to avoid creating another explosion.

(2) The safest and most effective method for fighting a battery well fire is through oxygen starvation. Secure the well and stop all ventilation within, including agitation air, to deprive flames of oxygen.

CAUTION

NEVER attempt to extinguish a battery fire by pouring water on the battery. The hydrogen and oxygen generated by electrolysis could produce a violent explosion.

c. Electrical Fire Prevention

- (1) Keep electric motors and generators clean.
- (2) Ensure proper maintenance is performed on electrical equipment, i.e., motors, generators, bearings, and filters.
- (3) Report overheating or arcing of any electrical equipment.
- (4) Keep air filters clean.

D0506. FIRST AID FOR ELECTRICAL SHOCK

a. Fundamentally, electric current rather than voltage is the criterion of shock intensity. The passage of even a very small current through a vital part of the human body can cause death. The voltage necessary to produce the fatal current is dependent upon the resistance of the body, contact conditions, the path through the body, etc.

b. It is imperative to recognize that the resistance of the human body cannot be relied upon to prevent a fatal shock from 115 volts or even lower voltage; fatalities from as low as 30 volts have been recorded.

(1) Symptoms of Electrical Shock. In the event of severe electrical shock, the victim could become very pale or "bluish." His pulse is extremely weak or entirely absent, unconsciousness is complete, and burns are usually present. The victim's body may become rigid or stiff in a few minutes. This condition can be caused by muscular reaction to shock, and it shall not, necessarily, be considered as rigor mortis. Therefore, artificial respiration shall be administered immediately, regardless of body stiffness, as recovery from such a state has been reported. Consequently, the appearance of rigor mortis shall not be accepted as a positive sign of death.

(2) Rescue of Victims. The rescue of electrical shock victims is dependent upon prompt administration of first aid. All electrically trained personnel shall be trained annually in cardiopulmonary resuscitation (CPR) procedures by an instructor certified by an authorized agency, such as the American Red Cross or the American Heart Association.

CAUTION

DO NOT ATTEMPT TO ADMINISTER FIRST AID OR COME IN PHYSICAL CONTACT WITH AN ELECTRICAL SHOCK VICTIM BEFORE THE POWER IS SHUT OFF, OR, IF THE POWER CANNOT BE SHUT OFF IMMEDIATELY, BEFORE THE VICTIM HAS BEEN REMOVED FROM THE LIVE CONDUCTOR.

(3) When attempting to administer first aid to an electrical shock victim, proceed as follows:

(a) Shut off the power.

(b) If the power cannot be deactivated, per step (a), remove the victim immediately, observing the following precautions.

1. Protect yourself with dry insulating material.

2. Use a dry board, belt, dry clothing, or other available non-conductive material to free the victim (by pulling, pushing, or rolling) from the power-carrying object. DO NOT TOUCH the victim.

(c) Immediately after removal of the victim from the power-carrying object, administer CPR.

(d) When providing initial first aid measures, any possible spinal injuries or fractures should be taken into account.

D0507. ELECTRONIC PRECAUTIONS

a. Definitions

(1) **Repair**. Removal or replacement, by any method, of any component, subassembly, module, circuit card, or conductor to bring malfunctioning equipment back to an operational status.

(2) **Corrective maintenance**. Alignment, adjustment, tuning, or troubleshooting of malfunctioning equipment per published maintenance or technical manual procedure.

(3) **Preventative maintenance**. Alignment, adjustment, tuning, or testing of operational equipment to ensure performance within published maintenance card or technical manual procedures.

b. Repair of electronic equipment is normally accomplished with the circuit deenergized. Every effort should be made to avoid making repairs to energized equipment. DO NOT repair energized electronic equipment unless you are using approved procedures from technical manuals or other documentation, or an emergency condition exists and the commanding officer has granted permission to perform such repair. In such an emergency, trained personnel shall accomplish the repair of energized circuits and an experienced technician or officer shall supervise. Electronic repair personnel should observe the safety precautions in section 3-4 of the Electronics Installation and Maintenance Book (EIMB), NAVSEA SE 000-00-EIM-100, General Handbook.

c. Corrective maintenance on energized electronic equipment is authorized when done according to published maintenance or technical manual procedures. Freelance corrective maintenance (i.e., maintenance without a procedure) on energized electronic equipment shall be performed ONLY with the specific permission of the commanding officer.

d. Preventive maintenance on energized electronic equipment is authorized when it is according to a published maintenance requirement card or technical manual procedures.

e. Perform preventive or corrective maintenance on energized electronic equipment only when duly authorized and trained on that type of equipment.

f. Whenever work on energized electronic equipment exposes the technician to 30 volts or greater adhere to the following precautions:

(1) Study the applicable schematic and wiring diagrams before servicing.

(2) Research into or enter energized electronic equipment enclosure for the purpose of servicing or adjusting only when prescribed by applicable technical manuals, maintenance requirement card, or other approved documentation.

(3) Obtain the commanding officer's permission whenever work on energized electronic equipment deviates from published corrective or preventive maintenance procedures.

(4) Station a safety observer capable of securing power and rendering adequate aid in the event of an emergency.

(5) Provide warning signs and suitable guards to prevent personnel from coming in accidental contact with dangerous voltage.

(6) Obey all warning signs and heed all equipment warning labels.

(7) Insulate the work from ground with approved electrical grade rubber matting. Installation requirements for electrical grade matting are contained in Chapter 634 or NSTM.

(8) Remove or snugly secure any loose clothing. Remove all jewelry.

(9) Insulate all metal tools.

(10) Use only one hand, if practical, in accomplishing the work.

(11) Wear electrical grade rubber gloves on both hands, if possible. If the nature of the work is too cumbersome to wear gloves on both hands, then a glove shall be worn on the non-working hand.

g. Reaching into deenergized equipment also requires special care and precaution.

(1) Study the applicable schematic and wiring diagrams before servicing.

(2) Ensure you are familiar with all circuits that must be deenergized and all voltage storing and high voltage components.

(3) Discharge all voltage storing components with an approved shorting probe.

(4) Do not touch a conductor or electronic component unless you have proven it to be deenergized by using a known, approved voltage tester.

h. Removal of a unit or part from the normal location within an assembly and the energizing of the unit or part, while it is outside the normal enclosure, removes the protective features such as interlocks, enclosures and the grounding. These safety features may then no longer function as designed. Ground the chassis and frame of all units removed for servicing and ground all circuits normally grounded in operation whenever power is applied to the unit.

i. Do not energize any equipment that is tagged out. Properly clear the tag out first.

j. Never defeat an interlock or built-in safety device. Modify such safeguard circuits only as authorized by the cognizant system command.

k. Refer to Chapter 300 of NSTM and Chapter 3 of EIMB General Handbook for additional precautions regarding electric systems.

D0508. TAG-OUT PRECAUTIONS

Submarine Force tag-out procedures shall be enforced per (COMSUBLANT/COMSUBPAC Joint Instruction 5101.2 (Series)) at all times. Enforcement is necessary during normal operations as well as during repair, construction, testing, or maintenance.